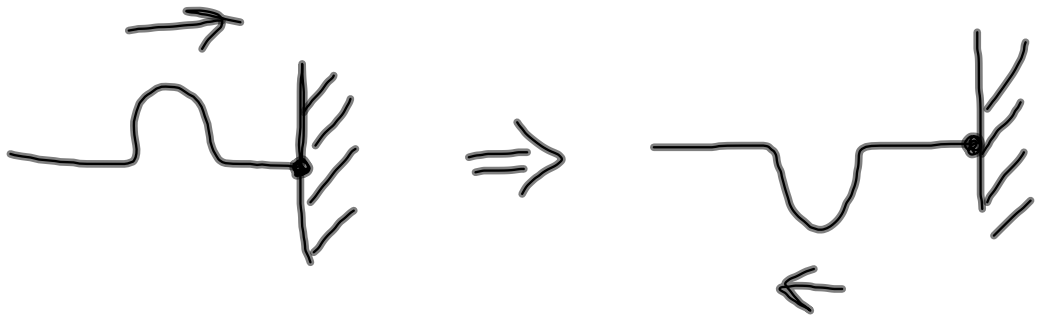
Test Friday, 5/4

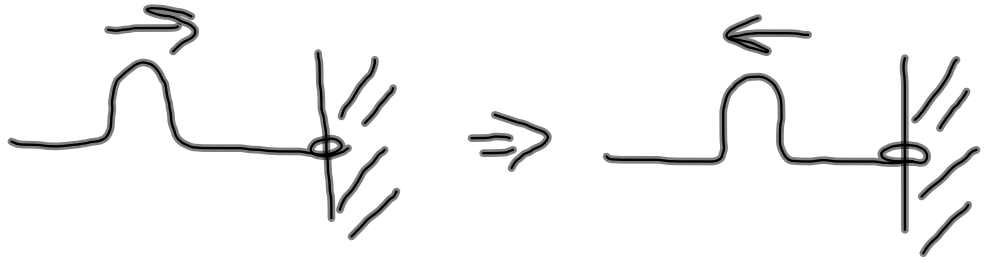
- Waves
- Sound
- Light

Reflections at a boundary:

- Fixed end: the wave "flips" the direction of amplitude

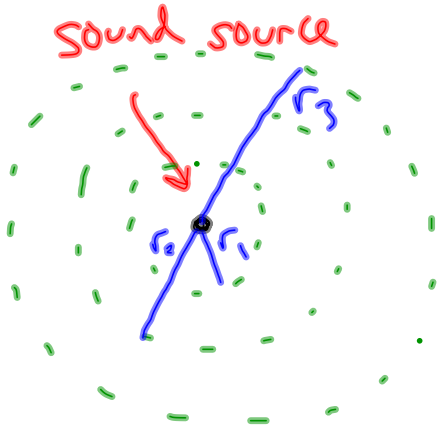


- Free end: the direction of wave's amplitude stays the same



Sound

- Pitch → perceived frequency of the sound
  - characterize as high, low, etc.
- Intensity → how loud something sounds



$I_1 > I_2 > I_3$

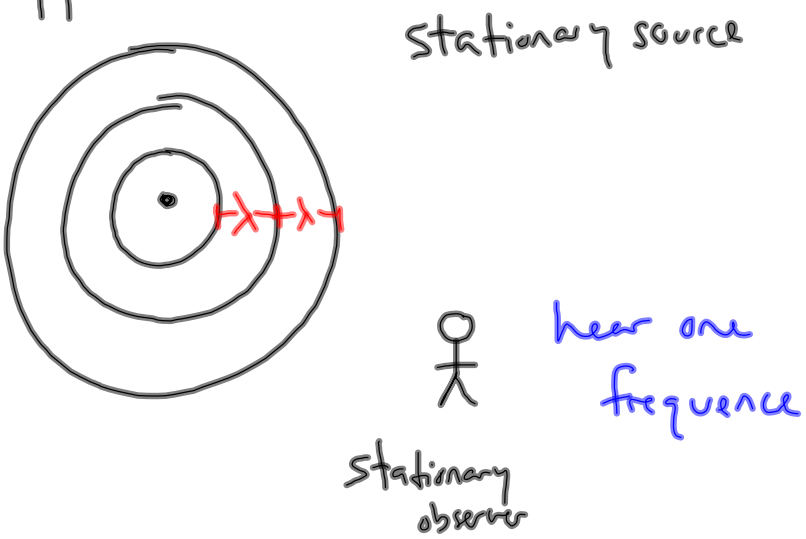
$$I = \frac{P}{4\pi r^2}$$

- P → power (W)
- r → distance from source (m)
- I → intensity (W/m^2)

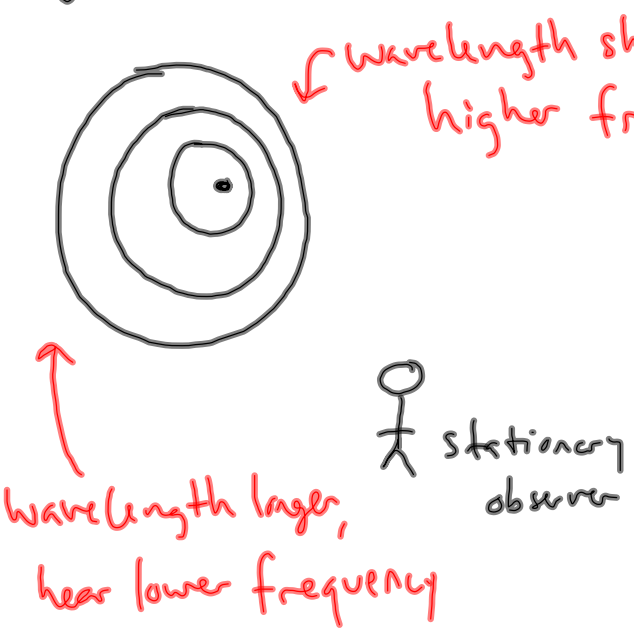
- Sound travels fastest through solids.

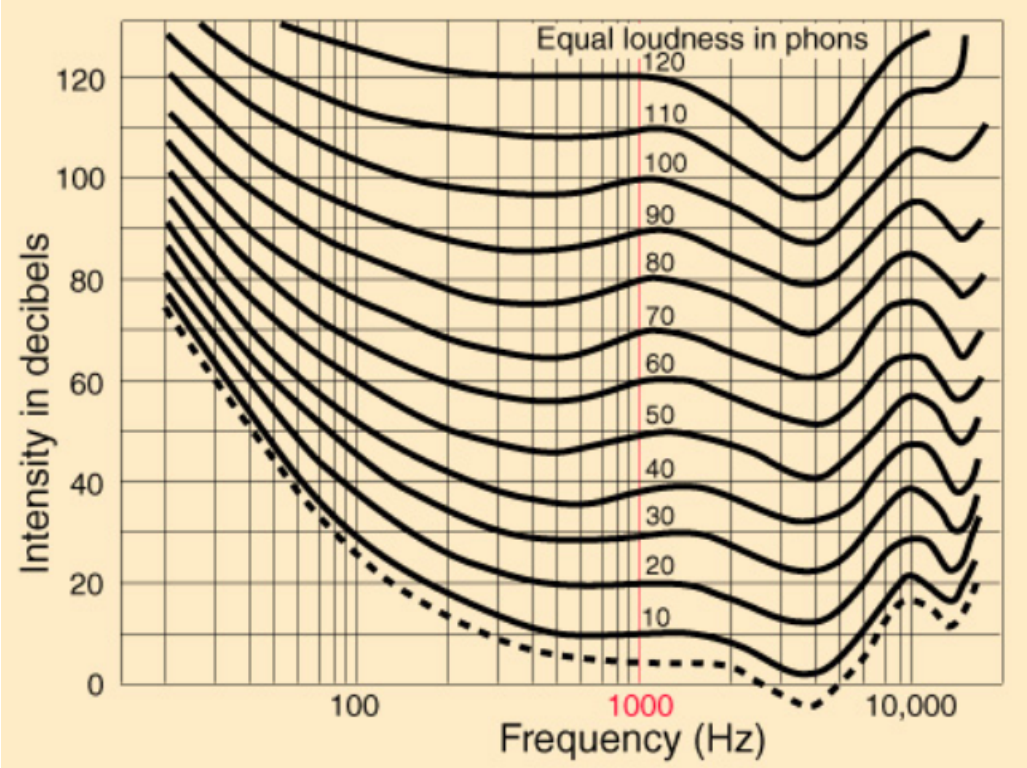
$$V_{solid} > V_{liquid} > V_{gas}$$

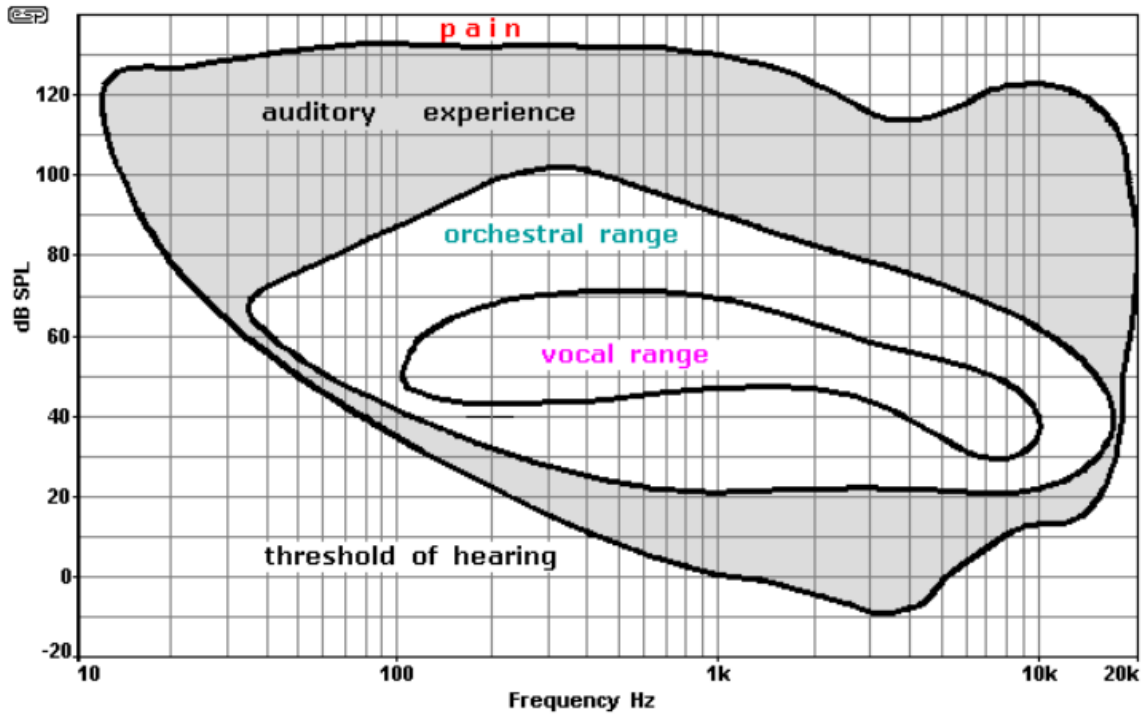
- Doppler effect:



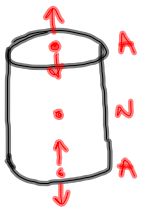
object moving to the right




Equal loudness in phons
120
110
100
90
80
70
60
50
40
30
20
10
Intensity in decibels
120
100
80
60
40
20
0
100
1000
10,000
Frequency (Hz)


pain
auditory experience
orchestral range
vocal range
threshold of hearing
dB SPL
120
100
80
60
40
20
0
-20
10
100
1k
10k
20k
Frequency Hz

- Open/open pipes:



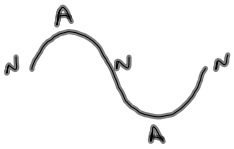
1st order frequency

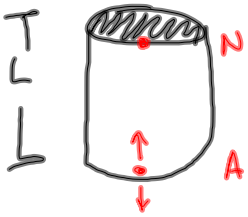
f_1

$\lambda_1 = 2L$

$$f_n = \frac{nv}{2L} \qquad n = 1, 2, 3, \ldots$$

- Open/closed:



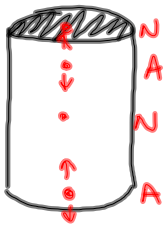


1st order frequency

f_1

$\lambda_1 = 4L$

- NO 2nd order frequency because we must have an antinode at open end.



3rd order frequency

$f_3 = 3f_1$

$\lambda_3 = \frac{4}{3}L$

$$f_n = \frac{nv}{4L} \qquad n = 1, 3, 5, \ldots$$

What are the first three order frequencies in a 2.45 m long pipe that is open at both ends? What are the first three order frequencies of this pipe when one end of the pipe is closed? Assume that the speed of sound in air is 345 m/s.

open/open → 1, 2, 3

$$f_n = \frac{nv}{2L}$$

$f_1 = 70.4$ Hz

$f_2 = 140.8$ Hz

$f_3 = 211.2$ Hz

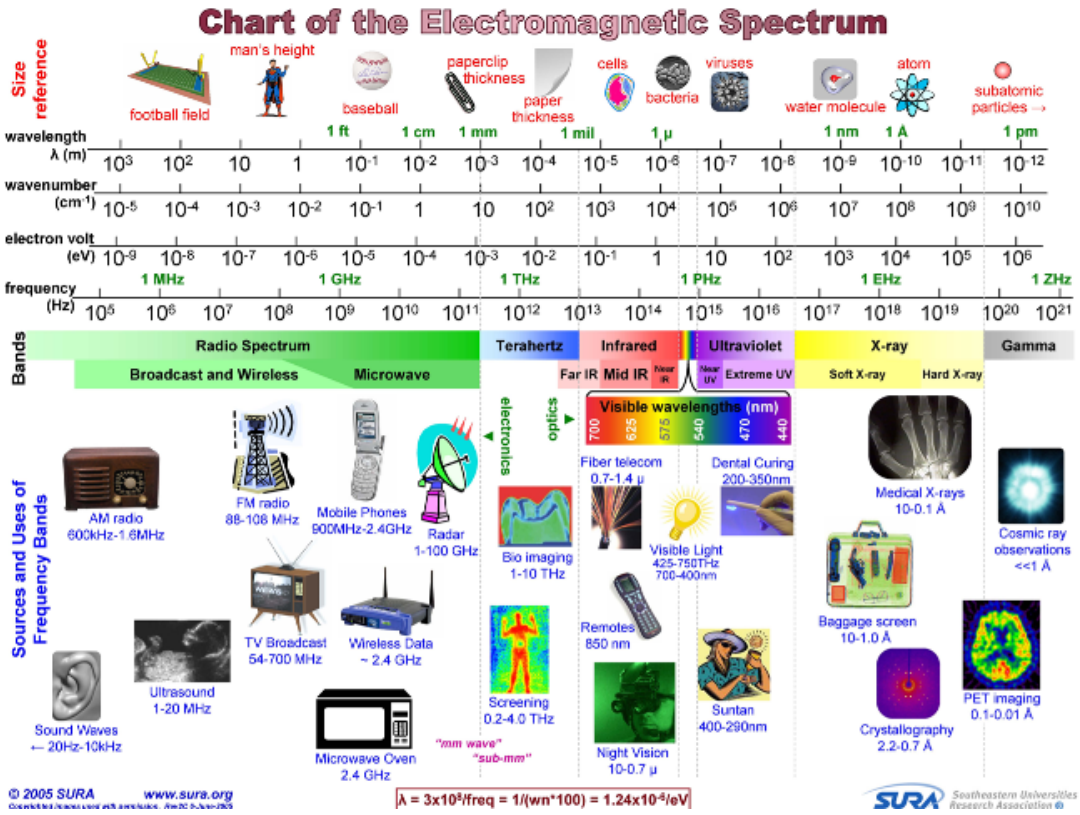
- open/closed → 1, 3, 5

$$f_n = \frac{nv}{4L}$$

$f_1 = 35.2$ Hz

$f_3 = 105.6$ Hz

$f_5 = 176.0$ Hz



- Light is technically known as electromagnetic radiation.